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MEDICAL RESEARCH IN THE CLINIC AND LABORATORY[1]

By Dr. SIMON FLEXNER

DIRECTOR OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

IT gives me very particular pleasure to address you —the graduating class, the trustees and faculty of this great institution—on an occasion which promises to be historic in the annals of medical education in the United States. Perhaps I may add that I feel highly honored, not only in having been invited to address you, but because of the close association in space of this institution and the Rockefeller Institute which immediately adjoins it to the south. I feel that I may take pride, which I hope is pardonable, in having had a very small share in determining the location of the New York Hospital and Cornell Medical College on its East River site.

I recall with great pleasure and satisfaction those early visits to the Rockefeller Institute of Mr. Edward W. Sheldon, the president of the New York Hospital, and Mr. Payne Whitney, a great benefactor, to discuss the question of site, and my eagerness that they should choose the particular one on which this monumental building now stands. It is true that the site then considered was far less extensive than the one ultimately assembled, but that is an unimportant detail. What is significant is that your splendid institution and the Rockefeller Institute should have become close neighbors and that they may come to react on each other in a manner to insure the realization of the main object for which they have been founded, that is, the advancement of the science of medicine in its many aspects.

May I say that I am so circumstanced that I can now glance backwards over a forty-year stretch of time during which medical education in this country has progressed with constantly increasing speed? It happens that I entered the Johns Hopkins Hospital

[1] Commencement address, New York Hospital—Cornell Medical College Association, June 8, 1933.

in the year 1890. The hospital itself had just got under way; the instruction in pathology and bacteriology was, in a sense, the sole university course given in the institution. That was three years before the formal opening of the medical school whose history was to prove so significant for medical education in the United States.

Do not mistake me: there had already been excellent teaching of medicine in the United States. But the Hopkins experiment was an innovation. Like all such things, it had a history, part of which was the visit of Thomas H. Huxley to Baltimore in September, 1876, and his outline of a modern medical curriculum; part was the appointment of Dr. William H. Welch in 1884 as professor of pathology in the university; and part was the courage of two women—President M. Carey Thomas, of Bryn Mawr College, and Miss Mary E. Garrett, of Baltimore—who with other women raised a fund making possible the opening of the school, and laid down conditions, then regarded as revolutionary to a high degree and to-day commonplaces of educational practise, prescribing a college degree, proficiency in the sciences and modern languages, and coeducation as the requirements for entrance on studies leading to the medical degree.

The revolution consists not in the innovation alone —that might readily have been superseded—but in the wide adoption of the principles of educational policy involved. In essence, this change from the old order was the recognition of the claims of science in medical education as a prime object of attainment. To-day we recognize widely that the pursuit of knowledge is not, indeed can not be, divorced from the teaching and practise of medicine. I hasten now to add that in the term "practise of medicine" I do not divorce clinical from laboratory medicine. Rather I hold that they are two sides of the same medal—a precious thing—which can never be divided in fact, as long as medicine as a profession actually lives.

There is, of course, no particular kind of knowledge which is superior to another, just as there is no division between knowledge gained by those who do and those who do not apply that knowledge in practise. So long as it is knowledge with which we are dealing, it is science; and science is one thing, not two. The only distinction to be noted between what may be called "clinical" as opposed to "laboratory" science is that the former is more difficult to attain. But that it can be attained, the history of three hundred years of investigation by experimental means amply shows. I see, therefore, in the organization of this great medical institution, which may quickly become a model for the world, recognition of the equal claims of the laboratory and the clinical scientist. Now, every laboratory worker is not merely an abstract scientist; many are on the very borders, indeed even within those borders, of clinical medicine; just as many clinical investigators are similarly placed with respect to the laboratory. This is as it should be; and I believe the crossing of these borders should be promoted in every feasible and advantageous way. In this manner, as much as or even more than in any other, can this great association express its faith in the ideals on which it is founded, and help to realize the future, which promises increased brilliancy, of medical science and practise in this country.

That the faculty of a medical college contributes to the advancement of science is, of course, a truism. It is not always recalled that a remarkable part of the growth of scientific medicine has come from the labors of practical men. By "practical men" I mean men who are engaged in the practise of their profession, besides which they find the time to respond to those uncontrollable impulses of guided curiosity to explore nature. I like to recall that gallant spirit, Dr. Samuel J. Meltzer, known to all the older teachers present here, who amid an exacting practise in New York regularly produced significant contributions to knowledge in the domains of physiology, pathology and clinical medicine.

But the most famous example of all time is William Harvey, a physician engaged throughout his life in a multiplicity of practical exploits, who yet found time to make the epochal discoveries attached to his name, which are the foundations of present-day physiology and embryology. Of this great man it has been said that his discovery of the circulation of the blood stands to medical practise in much the same relation as the discovery of the mariner's compass stands to navigation. Let us pause a moment to recall the salient facts of this discovery.

Harvey's epochal book was published in 1628. It seems probable that he began teaching his doctrines to his classes as early as 1616—the year of Shakespeare's death. For more than ten years, Harvey delayed any formal publication of his experiments and deductions, meanwhile inviting criticism and opposition to his views from all sources, in order that the complete truth, free from any falsities and misconceptions, might be disclosed. To-day, as it did then, his modest treatise stands as a landmark in human history, and a perusal of the methods of experiment employed and the mode of presentation adopted arouses feelings only of admiration and emulation.[2] The fundamental thesis of Harvey's teaching is expressed in almost winged words by a modern physiologist: that only by searching out and studying the secrets of nature by way of experiments can we hope to attain in the words of Job "to a comprehension of the wisdom of

[2] W. Harvey, "Motion of the Heart and Blood in Animals." Everyman's Library, 1906.

the body and the understanding of the heart,"[3] and thereby gain that mastery of disease and pain which will enable us to relieve the burden of mankind.

The announcement of the discovery produced a sensation; it was opposed, but not by the younger physicians. Something of present-day prejudice, fortunately diminishing rapidly, can be discerned in the fact that Harvey's medical practise fell off. Patients feared to put themselves under the care of one accused by the ignorant and envious of being crack-brained and of putting out new-fangled and dangerous doctrines. There was fortunately one man in a high place who showed lively interest in the discovery. Charles I supported Harvey and appointed him his personal physician.

If we penetrate a little farther into the genesis of Harvey's discovery, we may receive enlightenment and encouragement to-day. It was in Italy that Harvey came into relation with the scientific spirit of the age; indeed, the two independent geniuses, Galileo and Harvey, whose labors determined unexampled progress in the physical and biological sciences, were for a time contemporaries at the University of Padua.

It is a short step, only about half a century, from the astounding figure of Harvey to that of the overwhelming figure of Newton—the "lawgiver of the universe," in the phrase of his contemporaries. I venture to join these two men's names because they represent in truest measure the scientific spirit. Both men were enemies of mere speculation and upholders of the experimental method, and both were conspicuous by reason of the extreme caution with which they promulgated their discoveries. Newton, even less than Harvey, was possessed of the passion, verging on fanaticism, for mere scientific discovery which has distinguished many men. He had almost to be cajoled into the enunciation of the discovery of the law of gravitation, and he all but failed to complete the "Principia," because he detested controversy.

"I see I have made myself a slave to philosophy; I will resolutely bid adieu to it eternally, except what I do for my private satisfaction, or leave to come out after me; for I see a man must either resolve to put out nothing new, or become a slave to defend it."

It is not always appreciated that science is logical. The progression of discoveries is something not to be predicted often, but always to be explained. What seems, at times, to be the most revolutionary, because unexpected, discovery, is not so in fact. There is a thread of gold, as it were, running through and uniting all discovery; and there is even a connection, not always at once apparent, between discovery in the physical and in the biological sciences. This interrelation of all phenomena is becoming more and more impressive as scientific knowledge grows by leaps and bounds. And hence you will see in this center of medical activities, devotees, if I may use the term, of the physical as well as the biological sciences, and this not only in the laboratory, but also in the clinic, where more and more chemical and physical concepts and methods are being introduced into practise.

I remarked that science is logical. It may interest us to consider the testimony on this subject of great men in science. Newton is reported to have said that if the men of his generation saw further than their predecessors, it was because they stood on the shoulders of giants. Now, the giants of whom Newton was thinking were Copernicus, Tycho Brahé, Kepler, Galileo and Descartes. Just the other day, I found that this felicitous statement had been made in essence some four hundred years earlier, that is, in the twelfth century, by a lovable scholar, Bernard of Chartres, who said: "In comparison with the ancients, we are like dwarfs sitting on the shoulders of giants." The giants in this instance were doubtless the early Christian Fathers.

The idea of succession of scientific events and metaphors to describe them have impressed themselves on the greatest minds. In that enlightening book, "An Introduction to the Study of Experimental Medicine,"[4] recently made available in an English translation, Claude Bernard states:

> Each great man belongs to his time and can come only at the proper moment, in the sense that there is a necessary and ordered sequence in the appearance of scientific discoveries. Great men may be compared to torches shining at long intervals to guide the advance of science. They light up their time, either by discovering unexpected, fertile phenomena which open new paths and reveal unknown horizons, or by generalizing acquired scientific facts and disclosing truths which their predecessors had not perceived. If each great man makes the science which he vitalizes take a long step forward, he never presumes to fix its final boundaries, and he is destined to be outdistanced and left behind by the progress of successive generations. Great men have been compared to giants upon whose shoulders pygmies have climbed, who nevertheless see further than they. This simply means science makes progress subsequently to the appearance of great men, and precisely because of their influence. The result is that their successors know many more scientific facts than the great men themselves knew in their day. But a great man is, none the less, still a great man, that is to say—a giant.

It may be profitable to pursue this line of thought a little farther. One of Leonardo da Vinci's aphorisms was that truth is always the daughter of her period. We see this belief expressed in the oft-

[3] E. Starling. *Lancet*, 1923, ii, 869.

[4] Claude Bernard, "An Introduction to the Study of Experimental Medicine," English Translation, p. 41. The Macmillan Company, New York, 1927.

quoted phrase of Pasteur relating to the "prepared mind." What was meant here is that discovery comes to minds so fortified by accurate training as to be alert to perceive and quick to seize upon the novel and essential, which is turned at once to new and unexpected uses. "There is nothing new under the sun," and so it is with this favorite expression of Pasteur. In his use of it, he was merely expressing, perhaps unconsciously, the words which his great countryman Lagrange applied to Newton, "Such accidents only meet persons who deserve them," an expression which is quoted in a letter of the Scandinavian astronomer Hansteen, who wrote to Faraday in 1857 complimenting him on the discovery of electromagnetism.

There is, therefore, a kind of compulsion in science which determines its direction. Hence it happens that a discovery due to be made may be accomplished simultaneously by several independent investigators. The famous instance of this kind is the discovery of oxygen in England by Priestley, in France by Lavoisier and in Sweden by Scheele. Some discoveries are made out of time and must be rediscovered, perhaps even more than once. We have such an example in medicine; it chances to be an example of very great importance in theoretical and in practical medicine. The phenomenon of anaphylaxis, or increased sensitivity of the body to certain chemicals, in opposition to immunity, which is a state of diminished sensitivity, was probably first observed by Magendie early in the nineteenth century; it was rediscovered twice toward the end of the century, and its nature divined at the beginning of the twentieth century. In Magendie's case, he was engaged in trying on animals all sorts of things, helter-skelter, to ascertain their effects. In this way, he injected a rabbit with egg white, and on repeating the injection some days later he discovered that the egg white, at first harmless, now acted as a violent poison. What was needed before anaphylaxis could be properly understood was a development of the science of immunity, which only began between 1890 and 1900.

The French physiologist Magendie would be immortal if for no other reason than that he discovered Claude Bernard and gave him the opportunity for scientific studies. Nothing could be more impressive than the advance in physiological science in the period of a lifetime made by Claude Bernard through his systematic, imaginative, as well as accurate method of experimentation, in comparison with Magendie's stabs in the dark. Magendie said of himself: "Every one is fond of comparing himself to something great and grandiose, as Louis XIV likened himself to the sun, and others have had similar similes. I am more humble. I am a mere street scavenger of science. With my hook in my hand and my basket on my back, I go about the streets of science, collecting what I find."[5] Compare this capricious search for knowledge with the amazingly thoughtful, incisive experiments of Bernard, who, among many other epochal discoveries, gave us the first proof of internal secretion and the name which we still employ in endocrinology.

Among investigators, the rarest are those men with a presentiment of new truths; the far greater number merely develop and follow the ideas of others. In a few instances the presentiment is extraordinary, but it is always likely to be a brilliant example of the scientific use of the imagination. We must ever keep in mind that the outstanding discoveries in science are the accomplishments of real men and usually of great men. Now, as it has been well said, great men are just those who bring with them new ideas and destroy errors. They do not, therefore, respect the authority of their predecessors, and they do not move in an ordered way. While it is, of course, true that the discoveries of the great men preceding them stand at the base of their own discoveries, yet neither one nor the other is ever the promoter of absolute and immutable truths.[4]

If now we turn back to our own profession, it may be said that we have learned that there is no sharp line between health and disease, and no sharp distinction between the functions called physiological and pathological. A knowledge of the body will include all the biological processes with which we can deal. The animal body has often been compared to a watch, and the physician to the expert watchmaker, and it has been hoped that in due time doctors will be as good at their craft as watchmakers are at theirs. It is true, of course, as John Brown, the gifted author of "Rab and his Friends," has pointed out, that the watchmaker is not called on to mend the watch while it is going, and that this makes all the difference. But the simile is far more imperfect than this, since the most cunning of Swiss watches, which tolls the precise minute of the day or night, shows the day of the month, the quarters of the moon, and even other successive events, is so far simpler than the beautifully constructed and ingeniously integrated animal body that it is almost an offense to compare one with the other.

It is precisely this recognition of the multiplicity of the forces which control on the one hand the body in health and, on the other, those diversions which produce disease, that characterizes present-day medicine. Much of medical research, whether in the clinic

[5] Michael Foster, "Claude Bernard," "Masters of Medicine," p. 40, 1899.

or the laboratory, concerns itself with the detection and estimation of the power of these forces, and the means by which they may be controlled. We have thus witnessed the rise, not only of a chemistry or, if you will, a physics, as well as a biology of disease, but we are witnessing a spirited study of the underlying factors of constitution as affecting the health or the disease of individuals and of larger units or communities. Medicine, therefore, takes on an almost universal aspect; it is properly considered the most inclusive of the sciences and the most complex of the arts.

But the search for knowledge of the underlying conditions determining health on the one side and disease on the other is no longer confined to man himself. While he is the main object of our pursuit, he is by no means the only or even the chief object which is being investigated. Just as Francis Bacon announced that he proposed to take all knowledge for his province, so does the medical investigator to-day take all animated nature as his legitimate field of exploration. There are no closed compartments in nature into which man, animals and plants can be separately placed. All are related organically and, as we may say, united physiologically and pathologically. No essential biological division exists between man and the lower animals and plants, whether in respect to health or to disease. If, therefore, we would learn, and through learning grow more powerful and effective to prevent and to cure disease, to lengthen life and to increase happiness through security in all its varied forms, then we should endeavor to advance in biological knowledge, which alone can free us still further from the evils of disease.

To the members of the graduating class I offer my sincere felicitations and my wish that they may carry the spirit of the student into whatever branch of medicine they elect to follow. After all, it is the spirit which matters. The college sends you out with high hopes; may your own ambitions realize them.

THE STORY OF ISOTOPES[1]

By Dr. F. W. ASTON, F.R.S.

FELLOW OF TRINITY COLLEGE, CAMBRIDGE

THE story of isotopes is not a long one in time for it is practically all comprised within the past quarter of a century, but it presents many points of great general interest. The idea that atoms of the same element could differ in mass was repugnant to chemists and when, about 1910, Soddy proposed that the newly discovered data of radioactivity led inevitably to the possibility of leads occurring of different atomic weights but of identical chemical properties, he received much hostile criticism. The examination of naturally occurring leads by those who had the best reason to doubt the theory, the specialists in atomic weights, showed in due course that Soddy was right.

It is remarkable that the extension of the theory to the non-radioactive elements should have followed so closely, for this depended on a technical advance in methods of analysis of rays of charged atoms which had little or no relation to the discovery of radioactivity. Sir J. J. Thomson's parabola method of positive ray analysis suggested the probability of the inert gas neon being complex and an account of a partial separation of its isotopes was published in 1913, but the first definite proof of the general occurrence of complex elements composed of atoms of whole number mass was given by the mass-spectrograph in 1919. Chicago is closely associated with the early work on isotopes by the well-known researches of Harkins and Dempster. The latter announced the first analysis of a metallic element, magnesium, in 1920.

Aided by its focusing property the first mass-spectrograph had a resolving power sufficient for any element up to the rare earth group, and an accuracy of measurement of about 1 in 1000. During continuous use from 1919 to 1925 it was successfully applied to over 50 elements, the whole number rule was well established and the divergence of hydrogen from this roughly measured. Other slighter divergences were indicated but greater accuracy was required. In this connection one must not omit to note the work of the American Costa, who set up a mass-spectrograph in Paris and in 1925 published comparisons of some light atoms of an accuracy of 1 in 3000.

In the same year the original mass-spectrograph at the Cavendish Laboratory was replaced by a second one having double the resolving power and capable of comparing masses with an accuracy of 1 in 10,000. By means of this work was extended to heavier elements and a large number of new isotopes were discovered. Its high accuracy enabled the divergences from the whole number rule to be measured in many atoms. These expressed as "packing fractions" were found to lie on an interesting curve which has been used by Millikan and others for theoretical purposes. One of the most interesting discoveries made with the second mass-spectrograph was that uranium lead con-

[1] Abstract of an address before the General Session of the Century of Progress Meeting of the American Association for the Advancement of Science, Chicago, June 21, 1933.

tains an isotope 207 which is almost certainly the end product of the actinium series.

The next outstanding advance came from a totally different experimental source, the analysis of band spectra by the application of the quantum theory. By this means Giauque and Johnson discovered the rare isotopes 17 and 18 of oxygen in 1929 and similar discoveries followed in connection with carbon and nitrogen. These discoveries are all to be credited to American science which has taken an increasing share in the researches on isotopes in recent years. At the Bartol Institute, Bainbridge, by means of a very powerful apparatus of his own design, has corrected errors in the abundance of the isotopes of zinc and germanium, discovered new isotopes in tellurium and measured the packing fractions of several types of atoms, notably the important beryllium 9.

The latest and most spectacular discovery is that of the hydrogen isotope of mass 2. Following the discovery of the complexity of oxygen Birge pointed out that if the determination of the mass of the atom H_1 by the second mass-spectrograph was to be relied on hydrogen also should have heavier isotopes. Urey, Brickwedde and Murphy made a diligent search and were rewarded by the discovery of H_2. By means of their concentrated samples Bainbridge has photographed the line due to the molecule $H_1H_1H_2$ and so measured the mass of the new isotope. It is unique among isotopes for results of electrolysis give every hope of separating it in quantities on a practical scale and so opening up an entirely new field in chemistry. Its abundance in ordinary hydrogen is still uncertain. If, as results with the band spectra of HCl indicate, this is of the order 1 in 35,000 it is quite inadequate to account for the actual discrepancy which led in the first case to its discovery.

SCIENTIFIC EVENTS

NEW BUILDING FOR THE DEPARTMENT OF ZOOLOGY AT THE UNIVERSITY OF LONDON

THE Earl of Athlone, Chancellor of the University of London, formally opened the new building for the Department of Zoology and Comparative Anatomy, University College, London, on June 12.

According to the London *Times,* the site, acquired on the liquidation of Messrs. Shoolbred in 1931, contains a range of buildings surrounding a courtyard—since named Foster Court in commemoration of the first Provost of the college, Sir Gregory Foster—and the building on the east side of the courtyard is the one that has been adapted to the requirements of the department of zoology. It formerly consisted of stables on the ground floor and workshops on the two upper floors, which have been converted into laboratories, classrooms, a museum and other divisions.

The new main staircase occupies the eastern half of an internal tower, which has been carried up so as to provide a small fourth floor and a flat roof. Built into the eastern containing wall and placed between two plane trees is a gateway, the gift of the Pewterers' Company, in whose hall it stood before demolition. This is believed to date from about 1668–69, and it is suggested that it may be from a design by Wren.

The Earl of Athlone, who lunched at the college and unveiled a mural tablet in Foster Court to the memory of the first Provost, was joined by Princess Alice for the opening ceremony. In his speech he stated that the department of zoology was established in 1828, when Professor R. E. Grant, in his first course of lectures, proclaimed himself a believer in evolution. In 1874 Edwin Ray Lankester was appointed to the chair of zoology, and under his régime practical teaching was introduced. Lankester's personality drew to him many men of great ability, who passed on from the college to fill a large proportion of the chairs of zoology of the Empire. His influence determined the whole character of the teaching of zoology for half a century.

To ensure an adequate training for students of zoology it had become necessary to provide staff and laboratories for the study of genetics, comparative physiology and animal behavior. Through the generosity of the Rockefeller Foundation, the London County Council and Dr. Rodocanachi, it had been found possible to establish posts in those three subjects, to provide those who may be appointed to them with the laboratories and equipment and library facilities, and to bear the heavy cost of their research.

Professor Sir John Rose Bradford, chairman of the College Committee, presided, and was supported by Dr. Allen Mawer, Professor L. N. G. Filon and Professor D. M. S. Watson.

THE WISCONSIN ALUMNI RESEARCH FOUNDATION

THE Wisconsin Alumni Research Foundation has made grants-in-aid to the University of Wisconsin for next year in a sum sufficient to prevent the suspension of its research program which has been threatened by reduced appropriations.

The grants have been approved by the Board of Regents. The exact amount can not be determined until the revised salary schedules for 1933–34 have been fixed and other details of the research program completed.

The Research Foundation, a non-profit corporation organized by alumni interested in the development of research, derives its income from patents based on discoveries made by Wisconsin investigators and alumni who have voluntarily assigned their rights to the foundation in order to protect the public from unscrupulous exploitation and to build up a permanent fund for the support of research at the university.

Ordinarily, each year the foundation, of which Professor H. L. Russell is director, has used all its interest income from its invested capital in supporting university research. In the emergency which now obtains the trustees of the foundation have decided they could render no more useful public service than to add to the customary support they give the university a material sum from the anticipated income of the coming year to help meet the critical financial condition.

In announcing these grants, President Frank said:

Next year the University of Wisconsin will assign thirty-six of its productive scholars, for periods ranging from a few months to a full year, to the direction of between sixty and seventy important researches, some of them freshly authorized by the research committee of the university, but many of them projects already under way that would have to be abandoned but for the fact that the Alumni Research Foundation has stepped into the breach and saved the day for productive scholarship.

The terms under which the university will commission these scholars to carry on these researches involve a new and more economical system of graduate study, under which the traditional system of formal lectures and regularly scheduled seminars will be supplanted by an informal master-apprentice relationship between the thirty-six scientists and scholars directing these researches and their graduate students.

The greater the confusion of a time, the greater the need for sustained research in the natural and social sciences. But the current economic stringency is making it difficult for universities to keep even their normal research programs going. Many universities are now being forced backward just when they should, for the sake of the national future, be going forward.

The Alumni Research Foundation enables the university, despite the difficulties of the time, to carry on its research service to state and nation. Thanks to the statesmanlike action of the trustees of the foundation, Wisconsin, through this policy of research, correlated with a master-apprentice system of graduate training, again pioneers in the enrichment of university policy and university service to the state.

Associated with the thirty-six senior members of the staff, assigned to the direction of these researches, will be fifty or sixty research assistants, many of whose appointments might otherwise end this year because of lack of funds. The funds also will permit many young Wisconsin men and women who are completing their university training this year to continue their work in the scientific fields in which they have been specializing for from four to six years.

GRAVITY EXPEDITION IN CUBA

BETWEEN January 7 and May 3, 79 gravity stations were completed in Cuba, principally in the Provinces of Havana, Matanzas, Santa Clara and Camagüey. There were four stations in each of the other two provinces. This expedition was sponsored by a committee of the American Geophysical Union, and was made possible through the cooperation of the Cuban Government, the Compañía Petrolera Carco, the United States Coast and Geodetic Survey, the United States Naval Observatory and the department of geology of Princeton University. The object of the expedition was to determine direct gravity by means of the new Brown apparatus at certain key points selected in relation to data already available from the torsion balance surveys and structural studies completed by the Compañía Petrolera Carco. The field work was done by Lieutenant A. J. Hoskinson, of the Coast and Geodetic Survey. The theoretical gravity, both by the Helmert and Bowie formulas, together with the isostatic anomalies, has already been computed and will be published shortly, together with an analysis of the relation of the anomalies to the fundamental structural trends in the basement rocks of Cuba. A preliminary analysis of the anomalies shows that the Rio Cauto Valley is underlain by dense rocks, which tends to controvert the previous theory that this valley is synclinal. Following the experience of the recent marine gravity expeditions in the West Indies, and the pendulum expeditions in the Big Horn Basin, there is already abundant proof that pendulum observations, especially when the proper corrections are made for observable rock densities, afford an important and valuable addition to geophysical methods for determining subsurface structures, both on land and at sea.—RICHARD M. FIELD.

COMMITTEE OF DUTCH PROFESSORS ON BEHALF OF GERMAN JEWISH STUDENTS AND GRADUATES

AN academic committee of Dutch professors, of which Professor P. Van der Wielen has been appointed the chairman and Professor Dr. H. Frijda, Amsterdam, is acting as honorary secretary, has issued a statement which reads as follows:

The repressive measures against the Jews in Germany have especially heavily affected Jewish students and the university graduates of that country. Thousands of doctors, lawyers and those fulfilling lesser legal offices and those holding positions at the academies, many among whom have already given evidence of high scientific value, have been suddenly thrown out of their professions and deprived of their livelihood. Owing to the definite attitude of the authorities it has been made

almost impossible for Jews to take up an academic university career or to complete the studies upon which they had embarked. These circumstances have led large numbers to emigrate to countries affording them opportunities to continue their studies in universities with a view of eventually qualifying themselves in the profession they desire to enter in the country in which they have taken up their domicile.

As far as Holland is concerned, this has resulted in a very great increase in the number of students and already the situation as far as the students in general is concerned is causing not a little anxiety. For this reason necessary action must be taken to prevent the rush of German students increasing the difficulties under which the Dutch students in general are already laboring.

A committee consisting of professors from various Dutch universities and academies has been formed to consider what action can be taken with the Jewish intellectuals from Germany, to facilitate their desire to enter on a university career or who desire to continue their studies, without in any way conflicting with the interests of the Dutch students themselves.

To carry this work out, headquarters are being established in Amsterdam to cooperate as far as possible with similar committees in other countries for the purpose of advising refugees as to the possibilities for the continuation of their studies, the standards of scholarship demanded in this country and elsewhere and the prospect of academic careers in countries other than Holland. At the same time the committee will take upon itself the duty of emphasizing to would-be refugees the grave consequences of their action in deciding to leave Germany, notwithstanding the unfavorable conditions there. Finally, the committee will make every effort to provide opportunities to refugees carrying out professional duties to come in contact for further study courses.

GEOLOGICAL EXCURSION TO THE LAKE SUPERIOR REGION

DR. W. O. HOTCHKISS, president of the Michigan College of Mining and Technology, has returned from the iron districts of northern Michigan and Minnesota, where he arranged the itinerary for a group of international geologists, who will visit the iron and copper districts of the Lake Superior region early in August.

The International Geological Congress, which will be attended by delegates from all parts of the world, will be held in Washington, D. C., the latter part of July. During the congress nine excursions, all in the eastern part of the United States, will be offered, and after the meeting four special excursions will be available.

One of the special excursions will be through the glacial district in Illinois and southern Wisconsin, and two others will be trans-continental tours. One of the trans-continental excursions will take the northern route through the Rocky Mountain, Yellowstone National Park, down the Pacific coast and back over the southern route, giving the delegates an opportunity to visit a number of mining districts. The other trans-continental tour, which is designed especially for those interested in oil developments, will start over the southern route, up the Pacific coast and back over the northern route.

The fourth special tour will be to the Lake Superior mining districts which will include the copper district and the Marquette and Gogebic iron ranges in northern Michigan and the Mesaba iron region of Minnesota. Between twenty-five and fifty geologists are expected to make the tour to the Lake Superior district, the excursion promising to be one of the most popular of the four arranged for after the congress. Registrations for this tour will close on July 15.

While on these excursions the delegates will travel in chartered sleeping cars. Their first stop on the Lake Superior tour will be at Marquette on August 1, where they will spend one day on the Marquette range. They will be in Houghton August 2 to inspect the copper mines of this district and will then proceed to the Gogebic range, where they will spend one day. After visiting the Gogebic, the party will proceed to Duluth, where they will take buses to the Mesaba range for one day, and, returning to Duluth on the night of August 5, will entrain for Chicago to visit the Century of Progress Exposition.

OBITUARY

EDWARD F. MILLER, head of the department of mechanical engineering of the Massachusetts Institute of Technology since 1911 and a member of the faculty for forty-seven years, died on June 12 at the age of sixty-seven years.

DR. FREDERICK L. GATES, lecturer on general physiology at Harvard Medical School, died on June 17, of a fractured skull due to a fall while working in his laboratory. He was forty-six years of age.

DR. FRANK WARREN LANGDON, professor emeritus of neurology and psychiatry at the Medical College of the University of Cincinnati, died on June 9.

HERBERT KEIGHTLEY JOB, formerly Connecticut state ornithologist, and a member of the faculty of the Connecticut State College, and from 1918 until his retirement in 1932 director of the summer school of the National Association of Audubon Societies, died on June 17 at the age of sixty-eight years.

DR. FRANCIS J. FUCHS, head of the department of chemistry of St. John's University, Brooklyn, died on June 23, at the age of forty-four years.

SIR WALTER MORLEY FLETCHER, secretary of the British Medical Research Council, died on June 7. He was fifty-nine years old.

SCIENTIFIC NOTES AND NEWS

DR. C. U. ARIENS KAPPERS, director of the Central Institute for Brain Research at Amsterdam, delivered the first of a series of annual scientific lectures before the faculty, students and invited guests of the Chicago Medical School, on June 16. His subject was "The Phylogenetic Development of the Cerebral Cortex." The following day at the regular commencement exercises the degree of LL.D. was conferred on Dr. Kappers.

PRESIDENT ALEXANDER G. RUTHVEN, of the University of Michigan, formerly professor of zoology and director of the museum, received the degree of doctor of laws on June 12 from Denison University. Dr. Ruthven gave the address at the commencement exercises.

THE University of Arkansas has conferred the degree of doctor of laws on Dr. Coulter W. Jones, of the class of 1905, president of the Jones Chemical Company and discoverer of the process for extracting iodine from brine.

TRANSYLVANIA COLLEGE has conferred its honorary degree of doctor of science on Charles Allen Thomas, of the Thomas and Hochwalt Laboratories, Dayton, Ohio.

THE Charles B. Dudley Medal of the American Society for Testing Materials was presented to Dr. Samuel Epstein, of Columbus, Ohio, at the annual meeting which was held in Chicago from June 26 to 30.

THE Joseph S. Seaman gold medal of the American Foundrymen's Association for outstanding achievements in the metal casting industry, has been awarded to Dr. G. H. Clamer, president of the Ajax Electrothermic Corporation.

THE Lamme Medal of the Ohio State University, awarded "to a graduate of one of the technical departments for meritorious achievement in engineering or the technical arts," was given at commencement to Norman Wilson Storer, of Pittsburgh. Mr. Storer graduated in 1891 and since that year has been continuously in the employ of the Westinghouse Electric and Manufacturing Company. For thirty-five years of this time, he was closely associated with Mr. Lamme.

DR. ARNOLD SOMMERFELD, professor of theoretical physics at Munich, has been awarded the James Scott Prize for 1933 of the University of Edinburgh.

A FOUNDATION was created by the Health Organization of the League of Nations in honor of the late Dr. Samuel T. Darling, who met his death in 1925 by an accident, while conducting a mission on behalf of the League. The purpose of this foundation is the periodical award of a prize, known as "The Darling Foundation Prize," to the author of an original work on malaria. It is now announced from Geneva that the first award will take place on January 1, 1934, and that the foundation committee, on the recommendation of the Malaria Commission of the Health Organization of the League, has decided, at a recent meeting in Paris, to award the prize to Lieut.-Colonel S. P. James, of the Ministry of Health, London.

DR. GEORGE H. MEEKER, dean of the Graduate School of Medicine of the University of Pennsylvania, since he established it in 1918, was honored at a dinner on June 1. His portrait was presented to the university by Dr. George Morris Piersol on behalf of those in attendance and accepted by Dr. Alfred Stengel, vice-president in charge of medical affairs. Dr. Josiah H. Penniman, provost, was among the speakers, and Dr. George E. de Schweinitz, emeritus professor of ophthalmology, presided. Dr. Meeker founded the department of pharmaceutical chemistry in 1907 and continued as its dean to 1916, since which time he has been professor of chemistry in the School of Medicine.

DR. JOHN B. WHITEHEAD, dean of the faculty of engineering at the Johns Hopkins University, was elected president of the American Institute of Electrical Engineers for the year beginning August 1, 1933, as announced at the annual meeting of the institute held in Chicago. The other officers elected were: *Vice-presidents,* A. M. Wilson, Cincinnati; F. M. Craft, Atlanta; R. B. Bonney, Denver; R. W. Sorensen, Pasadena; A. H. Hull, Toronto; *Directors,* P. B. Juhnke, Chicago; Everett S. Lee, Schenectady; L. W. W. Morrow, New York; *National Treasurer,* W. I. Slichter, New York (reelected).

THE American Society for Testing Materials at the annual meeting which opened in Chicago on June 26 elected the following officers: *President,* T. R. Lawson, head of the department of civil engineering, Rensselaer Polytechnic Institute; *vice-president,* Hermann von Schrenk, consulting timber engineer, St. Louis; *Members of the Executive Committee,* Frank A. Barbour, consulting hydraulic and sanitary engineer, Boston; Arno C. Fieldner, chief engineer, Experiment Stations Division, U. S. Bureau of Mines; J. C. Pearson, director of research, Lehigh Portland Cement Company, Allentown, Pennsylvania; A. E. White, professor of metallurgical engineering and director department of engineering research, University of Michigan.

THE American Society of Clinical Pathologists held its twelfth annual convention in Milwaukee from June 9 to 12. Dr. A. G. Foord, of Pasadena, was inducted into office as president for the years 1933 and 1934. Officers were elected as follows: *President-elect,* Dr. F. H. Lamb, Davenport, Iowa; *Vice-president,* Dr. J. J. Seelman, Milwaukee, and *Secretary-treasurer,* Dr. A. S. Giordano, South Bend, Indiana. The Ward Burdick Award was given to Dr. A. H. Sanford of Rochester, Minnesota. The first prize for scientific exhibits was given to a group of four men consisting of Dr. H. S. Martland, of Newark, and Drs. A. O. Gettler, A. V. St. George and Charles Norris, of New York City. The second prize was awarded to Dr. W. D. Stovall, of Madison, Wisconsin.

THE annual election of the American Society of Plant Physiologists has resulted in the election of Dr. C. O. Appleman, of the University of Maryland, *president;* of Dr. H. R. Kraybill, of Purdue University, *vice-president,* and of Dr. A. E. Murneek, of the University of Missouri, *secretary-treasurer.*

AS part of the government's economy program the following geologists have been retired from the U. S. Geological Survey: Arthur Keith, Nelson H. Darton, Charles Butts, Charles E. Van Orstrand, G. P. Richardson, Frank T. Calkins, Louis M. Pringle, Arthur J. Collier, George Steiger and Arthur Coe Spencer.

COLONEL CLAUDE E. BRIGHAM, of the Chemical Warfare Service, has been appointed chief of the service with the rank of major general.

DR. JOHN ZAHORSKY has been appointed director of the department of pediatrics at St. Louis University.

THE retirement from active service is announced of J. L. Van Ornum, since 1899 professor of civil engineering at Washington University, St. Louis.

PROFESSOR H. G. GREENISH, professor of pharmaceutics at the University of London, is retiring owing to ill health.

W. V. LEWIS, of Gonville and Caius College, Cambridge, has been appointed university demonstrator in geography and Dr. N. W. Pirie university demonstrator in biochemistry.

AT the University of Oxford the following lecturers have been appointed as from October 1: H. E. Woodman, Downing, agricultural chemistry; Dr. H. G. Sanders, St. John's, agriculture, and H. H. Nicholson, Selwyn, agricultural chemistry. G. D. H. Bell, Selwyn, has been appointed demonstrator in agricultural biology.

PROFESSOR A. C. NOÉ, of the University of Chicago, has been appointed research associate in paleobotany on the staff of the Field Museum of Natural History. His connection with the museum will not conflict with his work at the university.

WILLIAM J. FOX, for many years assistant librarian at the Academy of Natural Sciences of Philadelphia, has been appointed librarian; Morgan Hebard, formerly curator of the department of entomology, wishing to be relieved of all administrative duties and to devote his time more fully to the care and study of his personal collection, has resigned as curator and has been appointed a research associate. James A. G. Rehn, formerly associate curator of the department of entomology, has been made curator to succeed Mr. Hebard.

THE International Association for Testing Materials has selected a commission for the study of viscosity. The members consist of the following: Dr. Guy Barr, National Physical Laboratory, England, *president;* Dr. S. Erk, Physikalischtechnische Reichsanstalt, Germany; Dr. Eugene C. Bingham, Lafayette College, United States; Dr. Paul Woog, professeur à l'école Nationale du Petrole, France; Dr. R. N. J. Saal, Amsterdam; Professor P. E. Raaschau, Copenhagen; Don Jose Arvilla, Madrid; Professor A. R. Matthis, Marcinelle, Belgium; Professor Prokopios Zacharias, Athens; Dr. Josef Varga, Budapest; Professor Modesto Panetti, Turin; M. Mazilu, Bucharest; Dr. J. P. Bohnenblust, Baden. The panel "for the realization of absolute units of viscosity" consists of Dr. Guy Barr, Dr. Eugene C. Bingham, Dr. S. Erk and Dr. Paul Woog.

PROFESSOR EDWARD W. BERRY, of the Johns Hopkins University, has sailed for Venezuela where he will spend the summer in geological work in connection with the anthropological excavations of Dr. Rafael Requena.

DR. ROY CHAPMAN ANDREWS, of the American Museum of Natural History, sailed for Europe on June 28.

PROFESSOR FRED C. SEARS, head of the department of pomology of the Massachusetts Institute of Technology, and Professor Walter Chenoweth, head of the department of horticultural manufactures, have left for Labrador, where they will spend the summer working with the Grenfell Mission, assisting in the work established by Sir Wilfred Grenfell.

THE plenary sessions of the International Commission on Illumination, originally scheduled for 1934, have been postponed on account of the world-wide depression. They are to be held in Germany in June, 1935. It is planned to hold an International Illumination Congress in connection with these sessions. The American Secretariats on factory and school lighting, aircraft lighting and lighting education have their work well along in preparation for the 1935 meetings. Questionnaires have already been circulated by several European secretariats. Papers on lighting questions of modern world interest are being planned.

ACCORDING to Science Service, the proposed reduction of 25 per cent. in the appropriations for the agricultural experiment stations will not take effect during the first three months of the fiscal year. President Roosevelt's reorganization order reduced the regular annual appropriation by $1,095,222 for the year beginning July 1, but representations of the injury that would result to fundamental research work in science and agriculture have caused official postponement. It is also hoped that the cuts may be mitigated for the balance of the year. Although final action has not yet been taken, a similar postponement of the 25 per cent. cuts in the extension service, the agricultural colleges and vocational education federal grants is expected to apply to the first quarter. This will involve the expenditure of $979,000.

THE *Experiment Station Record* reports that state appropriations in Kansas for the ensuing biennium will aggregate $1,881,700. This is a reduction from $2,631,582 for the present biennium, but of the latter amount $427,972 was impounded by the board of regents of the Kansas College and Station and returned to the state treasury. The new appropriations are thus far about 16 per cent. less than the present expenditures. The reductions include among other items the elimination of new construction and the soil survey and decreases for salaries and wages from $1,362,900 to $1,022,200, maintenance from $700,000 to $525,000, laboratory equipment from $40,000 to $30,000, veterinary research from $40,000 to $20,000, and extension work from $203,682 to $160,000.

AN expedition under the direction of Dr. Austin R. Middleton, biologist of the University of Louisville, and Dr. H. E. Enders, dean of the School of Science of Purdue University, has sailed from New Orleans to spend two months at the Lancetilla Experiment Station, not far from Tela, Honduras. The expedition will report on the feasibility of establishing a summer school offering college credit for study of tropical subjects in the Central American jungles. Members of the party will make collections of biological specimens for the two universities, and a study will be made of reptiles and amphibians, as well as of parasites, fungi and medicinal plants.

THE Rockefeller Foundation has presented $100,000 for extending the special researches on crystalline structures which are being carried on at the Davy Faraday Laboratory of the Royal Institution of Great Britain. A further sum of $250,000 has been raised for the same purpose, thus fulfilling the condition on which the gift was promised nearly three years ago. The researches are under the direction of Sir William Bragg, Fullerian professor of chemistry at the Royal Institution. Similar work on wool is being applied to practical problems of the textile industry.

A CORRESPONDENT of the *Journal* of the American Medical Association reports that Dr. Bellocq, recently appointed by the minister of public instruction as professor of surgical anatomy at the Faculté de médecine de Strasbourg, has been received by the students with shouts and groans and whistlings so disturbing that he has been compelled to retire. The dean, who intervened, was unable to appease the students, and the course has been omitted. The reason for the incident, which is supported by the physicians of Strasbourg, is, according to the correspondent, that the minister of public instruction has on two occasions appointed to chairs in the Faculté de médecine de Strasbourg physicians who had no previous connection with this faculty, one having come from Paris and the other from Toulouse. The minister is entirely within his rights, and several professors of the Faculté de médecine de Paris came from Lille, Nancy and Montpellier. But they occupied professorships in those cities, whereas the two physicians designated for Strasbourg have been recently advanced to professorships and had been previously heads of clinics in other faculties of medicine. It was thought in Strasbourg that all chances for the students and for the heads of clinics of the local faculty to progress would be closed if the professors that the minister sent were always heads of clinics coming from other faculties of medicine.

THE Field Museum Archeological Expedition to the Southwest, which conducted excavations on the Lowry ruin in Colorado during the summers of 1930 and 1931, but was suspended in 1932, is resuming operations this summer. Dr. Paul S. Martin, assistant curator of North American archeology at the museum, who was leader during the expedition's two previous seasons, left Chicago on June 16 to take charge of the work. The Lowry ruin is a site near Ackmen, Colorado, which contains the remains of an offshoot of the ancient North American culture known as that of Chaco Canyon. In the previous seasons the expedition exposed two kivas or ceremonial rooms, and collected pottery, prayer-sticks and other artifacts of the ancient Indians who inhabited the pueblo. It was ascertained that the middle period of the pueblo was probably somewhere between A. D. 800 and 1,000, but the time of the earliest occupation remains to be traced. The expedition is financed from funds provided by the late Julius and Augusta N. Rosenwald.

THE Paris correspondent of the *Journal* of the American Medical Association writes: "The old head-

quarters of the Academy of Medicine, in the rue des Saints-Pères, which were abandoned thirty years ago for the new magnificent quarters that it now occupies in the rue Bonaparte, have been undergoing some much needed repairs. The discoveries that have been made in the old quarters occupied by the academy for ninety years awaken surprise. The small hall in which the council met had a low ceiling and presented a paradoxical state of uncleanliness. When the academy moved to its new quarters, the old dusty carpet that covered the floor of this sanctuary was taken up. Under this carpet was found another carpet, also worn and even more dusty than the top carpet. Under the second carpet was found a third, and, the excavations being continued, ten old carpets, none of which appeared to have been ever subjected to a cleaning process, during the time that successive generations of venerable savants—from Depuytren to Pasteur and Dr. Roux—had passed over them, were removed! What a haunt for streptococci, staphylococci and tubercle bacilli the Academy of Medicine had become! And from these environs were promulgated by the great apostles of hygiene the far-reaching precepts of antisepsis. However, they all died at an advanced age, without their health having been impaired in the slightest by this uncleanliness. But they spent only a few hours each week in this environment."

DISCUSSION

"RED WATER" IN LA JOLLA BAY IN 1933

To those familiar with the ocean, it is well known that its colors are not uniform or constant. This is especially true of coastal and of relatively shallow waters. For a century or more, it has been known that changes of color are often caused by the presence of vast multitudes of small organisms, some of microscopic size. It is also fairly well known to some observers that changes of color due to particular types of organisms occur more frequently in some regions than in others.

In the San Diego region of Southern California, records of occurrence of "red water" caused by the presence of the microscopic organisms called "dinoflagellates" are rather few, instances having been reported for 1901,[1] 1907[2], 1917,[3] 1924[4] and in the present case for 1933. While it is not probable that these reports cover all, or nearly all, of the occurrences of "red water" in Southern California seas in a period of more than thirty years, it is probable that they do give a fairly good impression of the rarity of conspicuous occurrences.

In 1933, water of a "dirty red" or "muddy red" tinge was noticed near the pier of the Scripps Institution of Oceanography on May 17. On May 18, I began giving it a considerable amount of personal attention, terminated by the marked reduction of discoloration on May 31. On several of the fourteen days of occurrence the discoloration appeared to be nearly uniform in a zone of water within a half mile of shore over a distance of at least three miles around the shores of La Jolla Bay. On other days it appeared streaky, probably due in part to more wind disturbance. Fish seemed to act much as usual in this water, giving no observable indication of response to changes in oxygen content (not tested) or other derangements which might be suspected to occur.

On most days of the fourteen, I examined microscopically two kinds of samples, one obtained for another purpose by my assistant, Miss Easter Cupp, by filtering several gallons of water through No. 25 silk bolting cloth, the other obtained by merely dipping up the water without any kind of treatment. Regular daily catches were taken also by a settling method, but these were not examined microscopically.

The filtration samples were examined only under a binocular dissecting microscope. They showed a very great preponderance of dinoflagellates for a few days, a nearly equal occurrence of diatoms and dinoflagellates for two or three days, and a return to strong preponderance of dinoflagellates for the remaining time. On a number of days *Ceratium tripos* (O. F. M.) appeared to be the leading dinoflagellate, both volumetrically and numerically, although there were large numbers of species of *Peridinium* and of other species of *Ceratium* in each catch. However, in all catches there were such large numbers of the much smaller *Prorocentrum micans* Ehr. that it was very doubtful that the numbers of *Ceratium* were greatest in any case. The conspicuous golden yellow color of *Prorocentrum* also suggested the probability that it would contribute more than its share (quantitatively) to discoloration of the sea.

From the untreated samples I took single drops (roughly measured by pipette) and examined them *in toto* under the compound microscope. In some of them I found thirty to eighty specimens of *Prorocentrum* with no other organisms present. In most

[1] H. B. Torrey, *Amer. Nat.*, 36: 187–192, 1902.
[2] C. A. Kofoid, *Univ. Calif. Publ. Zool.*, 8: 187–286, 1911.
[3] W. E. Allen, *Special publ. Bernice P. Bishop Museum*, 7, 537–554. 1921.
[4] W. E. Allen, *Bull. Scripps Inst. Oceanog.*, Tech. Ser., 1: 347–356, 1928.

catches from one to six other forms were present (three species of diatoms and three species of dinoflagellates in one). The largest number of *Ceratium tripos* found in a single drop was two, but the number of *Prorocentrum* in that drop was 146. The general evidence of drop studies of the fourteen days suggests that the ratio of numerical representation of the two leading species was about fifty to one in favor of the smaller form.

These experiences show distinctly the unreliability of results of treating differing organisms alike, and the futility of applying methods of handling to those of smaller size merely because they have been successful with those of larger size and are convenient. They also show the possibility that *Prorocentrum* is more frequently prominent in production of "red water" than reports have indicated.

Worm larvae of undetermined affinities were the only animals actually seen using *Prorocentrum* for food. Many of them were gorged with intact specimens.

In the tall tubes used for daily collecting by the settling method, it was noted that a large percentage of killed material was held by the surface films and by the sides of the tubes. Microscopic examination of some of the supported particles showed them to consist mainly of clumps of three to six *Prorocentrums,* a most convincing illustration of the way in which agglutination or adhesiveness of small organisms may reduce accuracy of collecting by any method.

Because of their general interest these points are presented for publication now, since it is improbable that a full report can be prepared soon.

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INTERBED—A CONVENIENT STRATIGRAPHIC EXPRESSION

SEDIMENTARY formations are commonly made up of one dominant rock type in which occur interbedded layers of distinctive lithology; a shale formation may contain interbedded limestone layers; a sandstone may include interbedded shales. In many cases each interbedded layer consists of a single bed, an inch or more in thickness. Where such thin layers of different lithology are regularly and repeatedly interbedded a banded appearance is attained. In stratigraphic description these features have been referred to as "interbedded layers" or "intercalated beds," or some such expression that, when frequently repeated, as is necessary in some cases, becomes exceedingly awkward. In their place the term "interbed" can be used to advantage.

An interbed is strictly a single bed lying between other beds from which it differs somewhat in lithology. The term can be used for more than one bed in the case of thinly laminated layers of small thickness, such as shale interbeds. It does not refer to a collection of beds that on account of their thickness or continuity can properly be called a tongue, a member or a formation.

Fossiliferous limestone interbeds occur in a late Ordovician series near Matapedia, Quebec, and it was to facilitate reference to these important layers that I first had occasion to use the word. In the form of a noun, "interbed" can be modified by descriptive adjectives which appear cumbersome when used with the adjective "interbedded." The expression "varve-like interbeds" has been used by C. L. Baker in describing portions of the Haymond formation in western Texas.[1] To my knowledge this is the only occasion that the expression "interbed" has appeared in print.

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ON THE EFFECT OF MOCCASIN VENOM UPON A RATTLESNAKE

LITTLE or no definite information on inter-generic or inter-specific venom susceptibility among American crotalid snakes seems to be available. Beyond a few brief and general comments, such as "poisonous snakes are immune to their own venoms and to the venoms of each other" and "snakes are immune to the venom of their own species but may be susceptible to that of a closely related species," the literature is silent on this subject. As a matter of general interest, and because of its suggestiveness in this little-worked field, it seems desirable to record an instance in which the venom of a cottonmouth moccasin, *Agkistrodon piscivorus* (Lacepede), is known to have been fatal to a rattlesnake, *Crotalus atrox* Baird and Girard.

In connection with a demonstration of venomous snakes for a boy scout troop about 9:15 P. M., November 18, 1932, a four-foot western diamond rattlesnake was severely bitten by a thirty-inch cottonmouth, as the former was being lifted from a box in which both had been confined. The bite was lateral in position and about five inches anterior to the tail. Both fangs of the moccasin are thought to have penetrated the body of the rattlesnake, although the punctures could not be found. Little attention was given to the matter at the time, but the following morning, when the snakes were returned to their enclosures in an animal room of the Zoological Laboratories, it was noticed that the body of the rattlesnake was swollen near the region of the bite and that the skin visible between the scales was of a dark

[1] C. L. Baker, "Erratics and Arkoses in the Middle Pennsylvania Haymond Formation of the Marathon Area, Trans-Pecos, Texas," *Jour. Geol.*, xl: 580, 1932.

greenish-blue color. No further change was noticed until the third day, about seventy-one hours after the bite, when the snake was found bleeding from the mouth with its head inclining over the edge of an empty water pan into which approximately 20 cc of bloody fluid had fallen. It was very sluggish and responded only slightly when touched. When removed from the cage and examined, it was evidently almost dead. Occasional spasmodic twitchings of small portions of the body occurred, however, over a subsequent period of two and a half hours.

Post-mortem examination of the region of the bite revealed much discoloration, extravasation of blood and lymph, and evidence of general histolysis in all tissues of the body wall. Extending along the left side of the body cavity adjacent to the lung was another area which seemed to have been attacked by venom from another bite which probably occurred as the rattlesnake was being replaced in the box. Marked histolysis was evident in this region also. The lung was filled with blood which did not coagulate, extravasation in this organ being responsible for the bleeding at the mouth before death.

Almost every one who has kept living venomous snakes for study has observed that on occasion they fortuitously bite themselves or others of their own or closely related species without the occurrence of noticeable reactions. I have seen a timber rattlesnake, *Crotalus horridus* Linn., sink its fangs deeply into its own writhing body when pinned to the ground by a collecting hook; a western diamond rattlesnake, *Crotalus atrox* Baird and Girard, bite another of its own species, giving it two powerful strikes in quick succession; and a prairie rattlesnake, *Crotalus confluentus confluentus* (Say), bitten by a copperhead, *Agkistrodon mokasen* Beauvois, the fangs penetrating deeply enough to cause a distinct flow of blood from the wounds. Each of these snakes was examined frequently during the two or three days following the bites and none suffered apparent effect.

From the fact that the cottonmouth moccasin feeds very largely upon more or less aquatic, cold-blooded prey, it is perhaps to be expected that its venom would prove to be more toxic to other crotalids than that of species feeding chiefly or exclusively upon warm-blooded animals.

It is unfortunate that on a matter of so much popular interest so little definite knowledge exists. Some carefully controlled experiments by a properly qualified and adequately equipped investigator could be expected to produce interesting and useful results.

H. K. GLOYD

UNIVERSITY OF MICHIGAN

THE EFFECT OF MORPHINE ON THE ANAL SPHINCTERS

IT is a well-known fact that moderate doses of morphine produce sustained contractions of the cardiac and pyloric sphincters of the stomach and of the sphincter of the urinary bladder. We could not find any data in the literature relative to morphine action on the internal and external sphincters of the anus.

In three cats and three dogs it was shown that doses of morphine varying from three to ten mgm per kgm of body weight administered intravenously produced marked and sustained contractions of both sphincters of the anus. The animals were under moderate ether anesthesia, the trachea clamped, and thus asphyxia was produced with simultaneous relaxation of the sphincters ani. This relaxation is maintained for some time after the animals are again allowed to breathe. However, if the animals had received morphine previously, there was either no or only an evanescent relaxation of the sphincters during and after asphyxia.

Double vagotomy had no influence on the effect of morphine on the sphincters, nor did the high thoracic transection of the cord at the level of the second thoracic vertebra prevent the contraction of the relaxed sphincters upon the administration of morphine. In one dog with high thoracic transection of the cord following morphine administration the relaxed sphincters immediately contracted but relaxed again upon induction of asphyxia.

These results might have some bearing on certain surgical routine procedures and throw doubt on the reliability of the state of the anal sphincters as an indication of the degree of anesthesia following premedication with morphine.

THEODORE KOPPANYI
WILLIAM S. MURPHY

GEORGETOWN UNIVERSITY SCHOOL OF MEDICINE

QUOTATIONS

SIR WALTER FLETCHER

BY the death of Sir Walter Fletcher this country has lost one of the most devoted and most distinguished of its public servants. Alone, perhaps, among his contemporaries Fletcher recognized fully the need which existed for organization in the field of medical research. The opportunity to effect this organization came to him with his appointment as secretary of the newly constituted Medical Research

Committee, and he made of that committee, in the space of a few years, one of the most distinguished and useful bodies in the Empire. When the committee was transformed into the Medical Research Council he began at once to build on the new foundations. Wherever good work was being done in any part of the Empire he asked leave to help that work, and where no work was being done he took steps to supply new ideas and to provide the means of carrying them out. There is scarcely a university or medical school in the Empire which is not in some way indebted to him, and the part he played in some of the most brilliant studies of the last quarter of a century was of a kind to inspire the whole profession of medicine with respect and affection. Fletcher was friend to every honest seeker after truth and he possessed in special degree the faculty for friendship. His loyalty was unquenchable and he served no ends except those of the good of his fellows. It is no accident that his great influence was exerted during one of the most productive periods in the history of British medicine. He was in large measure the architect of success. Because he gave his whole strength to the conquest of disease and the pursuit of knowledge about health, millions of his fellows to-day are his beneficiaries.—*The Times, London.*

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A CHAMBER FOR EXPERIMENTALLY FREEZING HORTICULTURAL PRODUCTS AT VERY LOW TEMPERATURES

IN the course of experiments in the freezing preservation of fruits and vegetables, different temperatures have been employed to study the effects of different rates of freezing on the subsequent quality of the products. In this work samples of material in individual quantities of one pound or less have been used, and the temperature has been controlled at will from 32 deg. F. to a minimum of −100 deg. F.

In order to obtain temperatures below −10 deg. F. the refrigerating qualities of solid carbon dioxide were employed, using ordinary denatured alcohol as the medium of heat transfer from the container of the product to the solid carbon dioxide.

The methods used and the apparatus devised for this work are somewhat similar to those employed by others in experimental freezing of fruits or fruit pulps but differ in important particulars.[1,2] The present article describes the apparatus in detail together with the procedure in its use which enabled sustained temperatures as low as −100 deg. F. to be maintained. In view of the increasing attention being given to the study of the preservation of fruits and vegetables by freezing this description of the apparatus and its use is given for the benefit of other investigators.

The frame of the freezing chamber is solidly constructed of wood. Its walls are sheathed on the outside with galvanized sheet iron and are sheathed on the inside with thin sheet copper. The out dimensions are: Length, 28 inches; width, 34 inches, and height, 34 inches. Four inches of sheet cork are used for insulation in the sides and six inches of cork in the bottom.

The lid is constructed similar to a cold storage door with four inches of sheet cork insulation and double contact closure. A chain stop is used to hold the lid in an upright position when opened.

The capacity of the copper-lined refrigerating chamber is about seven gallons of liquid, when the chamber is ready for operation.

In order to facilitate heat transfer, the solid carbon dioxide is held in two copper boxes, set away from the side walls and bottom of the refrigerating chamber about one and one half inches and separated from each other in the center by a space of four inches. In this center space a double tier rack is placed upon which to rest the small containers of the product to be frozen. The capacity of the rack is eight No. 2 cans or six of the low type cans developed for frozen fruits and holding about one pound of material.

The two copper boxes are weighted with scrap iron to overcome their buoyance when immersed in the denatured alcohol. These boxes are equipped with copper lids, having wooden knobs so that the tops may be lifted conveniently and without danger of freezing the hands even when very low temperatures prevail in the freezing chamber.

These two boxes for the solid carbon dioxide have the following outside dimensions: Length, 14 inches, width, 5½ inches, and height, 14 inches. They are made of fairly thin sheet copper, and the lids slightly overhang the boxes in order to minimize the drip of alcohol into them as the containers or frozen product or the supporting rack are lifted out.

The two copper chambers were given the specified width in order to accommodate half blocks of solid carbon dioxide as ordinarily manufactured. However, in practise, it has been found that it is sometimes desirable to break up the block into smaller pieces.

[1] W. H. Harrison, Continental Can Company, Chicago, Illinois. Correspondence to the writer, December 29, 1931.

[2] D. G. Sorber, "A New Quick Frozen Fruit Product," *Fruit Products Journal*, 11: 229–230, 249, 255, April, 1932.

Temperature records are obtained by means of a toluol-filled thermometer suspended at the side within the chamber. This necessitates raising the lid and the thermometer in order to read the latter, but this has not been found to be very inconvenient and if quickly done accurate reading can be obtained.

It has been found that sufficient agitation of the liquid is ordinarily produced by the immersion of the warm cans into the very cold denatured alcohol. Agitation of the liquid can be increased by dropping small pieces of solid carbon dioxide into the liquid at the corners of the chamber. By the use of a suitable shaft and rotating clamp connected to a small motor, outside the box, mild agitation of the can contents may be provided during exposure to the very low temperatures.

In order to obtain very low temperatures in the chamber, it has been found best to load the two copper boxes during the evening preceding the day of use. The temperature drops rapidly in the liquid and it is possible to have –20 to –40 degrees F. within a few hours, but the temperature seems to become better stabilized if overnight cooling is employed, and of course, a much lower temperature level finally is reached.

With constant use, it is found that about seventy-five pounds daily of solid carbon dioxide suffices to keep the temperature of the liquid at very low levels, and of course lesser amounts suffice, as the operating temperatures are raised.

The writer was assisted in the design and construction of this freezing apparatus by Mr. C. M. Romaine, of Heiser's, Inc., Seattle, Washington.

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CELLOPHANE MEMBRANES FOR TAMBOURS

THE writer has been using a Cellophane membrane on a pneumatic recording tambour for several months and finds it very satisfactory. It seems to be at least as sensitive as the usual rubber membrane and is much more durable. The original membrane has been in daily use, recording the breathing of white rats, and is still airtight, despite much rough handling.

The Cellophane removed from cigarette packages is of the correct thickness (.001 inch) for low pressure systems. Before mounting, it should be softened by brief immersion in warm water. It may then be fastened to the tambour without danger of cracking, and secured with thread or rubber bands. Rubber cement may be used to seal the edges. If the membrane is not sensitive enough, it may be stretched by forced inflation of the tambour. A light rubber band, stretched over the writing arm near its fulcrum, will insure positive action. The sensitivity of the membrane is determined chiefly by the amount it is stretched, but the thickness of the membrane and the tension of the rubber band have some influence. This type of membrane is very sensitive in its middle range, but will stand surprisingly high pressures without damage. It continues to record at high pressures, but with decreased amplitude. This characteristic is a great advantage where sudden large variations in pressure are frequent, for it prevents the writing point from fouling other markers or leaving the recording surface. This graded sensitivity, together with its relative freedom from deterioration, makes the Cellophane membrane extremely convenient for pneumatic recording.

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SPECIAL ARTICLES

X-RAY STUDIES OF VERY COMPLEX MIXTURES OF LONG CHAIN COMPOUNDS

IT has been reported in a preliminary note[1] that solid solutions may be obtained by mixing pure fatty acids of considerable variation of chain length. This is true for any number of components. In the x-ray studies of such mixtures spacings are observed which correspond to an "average" chain length. Such results are in conflict with the general opinion.

However, we have completed this investigation in every detail, and publication (F. B. Slagle and Emil Ott) will follow shortly.

[1] Emil Ott and F. B. Slagle, *Jour. Phys. Chem.*, 37: 257, 1933.

Due to the importance of these results in connection with the interpretation of x-ray diagrams of high-polymers of a chain-like structure it seemed imperative to extend such studies to other types of long chain compounds, the results of which are briefly reported here.

The following equimolar mixtures of normal alcohols were studied: the nine alcohols C_{10} to C_{18} and the six alcohols C_{13} to C_{18}. Complete solid solution formation is evident in both cases, since only one crystal spacing (in various orders) in the direction of the c-axes is observed. Inasmuch as the usual modification of the alcohols has the chain axes perpendicular to the base it is possible in this case (con-

trary to the case of the fatty acids) to find out what the meaning of the composite spacing is. Calculations show that it corresponds within the experimental error to the arithmetical average of all the components. It is probably justified in other cases to consider the spacing of the mixture also as average, provided the proper modification of the substance is considered.

Solid solution was also observed in the mixture of the normal paraffines C_{19}, C_{24}, C_{32} and C_{36}.

Since solid solutions of chain compounds may be obtained with such large relative changes in chain length it might be anticipated that the variation of the nature of end groups, provided the general shape of the molecules is the same, would not interfere with the solid solution formation. With this in view the approximately equimolar mixtures of the following substances were studied: (a) C_{18} acid, C_{18} acetate, C_{18} bromide and C_{19} hydrocarbon and (b) the ten normal fatty acids C_{10} to C_{19}; the six normal alcohols C_{13} to C_{18}; the two normal bromides C_{17} and C_{18}, the three normal acetates C_{16} to C_{18} and the four normal hydrocarbons C_{19}, C_{24}, C_{32} and C_{36}. In each case only one phase, with one definite crystal spacing in the direction of the chain axes (indicated to the fifth order), was obtained.

It appears to us, then, that it is safe to say that in general long chain compounds of quite a variation of length and type will form solid solutions. Also, it is possible, in spite of the complexity of such mixture, to observe average chain lengths in an appreciable number of orders. It appears, therefore, that it should be possible to obtain a similar effect in certain high polymers. In general, this has not been observed; however, there exists one piece of work dealing with this effect.[2]

In view of the results mentioned above, its reality can not be doubted any longer.

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MUCIFICATION OF THE VAGINAL EPITHELIUM OF IMMATURE MICE FOLLOWING INJECTIONS OF FOLLICULAR FLUID

HARRIS and Newman[1] proposed a test for the potency of extracts of corpora lutea based on the appearance of mucus-like cells in the vaginal epithelial of the adult mouse. Meyer and Allen[2] disputed the validity of this test because they were able to produce mucification in castrated rodents with dilutions of amniotin and theelin.[3] Both of these substances are commercial products standardized for the oestrogenic hormone. Harris[4] later pointed out that when "normal" instead of castrated mice were used he was unable to produce vaginal mucification. He concluded that "the injection of an oestrous preparation into otherwise normal mice does not bring on mucification of the vaginal epithelium."

In order to settle the point at issue, immature mice were injected with follicular fluid aspirated from the sow's ovaries. The sow's ovaries were obtained the day the animals were slaughtered, kept on ice and used the following day. Six injections of 0.2 cc each, given at six-hour intervals on two successive days, were administered to all the animals which lived over twelve hours.

The mean age of the first oestrus of the animals in this colony was 30 days, S.D.M. 0.5. All the experimental animals were killed at a mean age of 18 days, S.D.M. 0.5. Mirskaia and Wiesner[5] have shown that mucification may develop six days before the first oestrus. By killing the animals at an average of twelve days before the first oestrus, the mucification normally found prior to the first oestrous smear should have been avoided. The immaturity of the animals at death was also attested by the condition of the ovaries. In none of the ovaries of the seventeen animals examined were mature follicles or corpora lutea present.

Twenty animals in all were injected. They were killed twelve to seventy-two hours following the first injection. Sections were made of the vagina, uterus and ovaries. The vaginas from the four mice killed twelve hours after the first injection showed mucus like epithelial cells at the distal portion. The upper part of the vagina was closed. Five vaginas examined twelve hours later were found to be patent throughout. The epithelial border was wider than in the first group, the peripheral mucoid cells showed vacuolization. Two animals killed at thirty-six hours showed the mucoid vaginal cells higher and more vacuolated with cornified cells forming beneath. Three animals killed at forty-eight hours showed about the same picture as seen in the twenty-four

[2] Emil Ott, SCIENCE, 71: 465, 1930. *Z. f. phys. Chem., B, 9,* 378, 1930.

[1] Reginald G. Harris and Dorothy M. Newman, "A Practical Test for Potency of Extract of Corpora Lutea," SCIENCE, 74: 182, 1931.

[2] Roland K. Meyer and Willard M. Allen, "The Production of Mucification of the Vaginal Epithelium of Rodents by the Oestrus Hormone," SCIENCE, 75: 111, 1932.

[3] Theelin prepared by Parke, Davis and Company; amniotin prepared by E. R. Squibb and Sons.

[4] Reginald G. Harris, "Mucification of the Vaginal Epithelium of Mice as a Test for Pregnancy-Maintaining Potency of Extract of Corpora Lutea," SCIENCE, 76: 408, 1932.

[5] L. Mirskaia and B. P. Wiesner, "On the Occurrence and Mechanism of Prepuberal Mucification." Proc. Second International Congress for Sex Research, 408, 1931.

hour group, except that the cornified cells of the vagina had become more distinct. The periphery of the vagina was still lined by cells of the mucoid type. The four animals in the sixty-hour group all had cornified vaginal cells. In some instances, remnants of the mucoid cells could be seen clinging to the border, others were free in the lumen. Twelve hours later an examination of the vaginas of two mice showed a complete cornification, no trace of mucoid cells was seen, cornified cells were being shed and the borders becoming approximated.

The uteri of these animals showed progressive changes. At twelve hours a slit-like opening lined by cuboidal epithelial cells was present. At seventy-two hours the uteri showed widely distended lumina surrounded by elongated cells.

Follicular fluid from the sow's ovary may therefore cause mucification, for about 60 hours, of the vaginal epithelium in the normal immature mouse. This would invalidate the usefulness of a test depending upon the early appearance of mucus-like cells as an index of corpus luteum extract.

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STUDIES ON THE ETIOLOGY OF EGYPTIAN TRACHOMA

A BACTERIOLOGICAL investigation of trachoma, as it prevails in Egypt, was carried out in the Memorial Ophthalmic Laboratory at Giza (Cairo) from February to April, 1933. We are indebted to the officers of the Government Public Health Department and to Dr. R. P. Wilson, the director of the laboratory, as well as to the members of its staff, for their wholehearted cooperation.

The cases of trachoma studied conformed clinically to the disease as it occurs in America among Indian and white races. We obtained tarsectomized tissue—the tarsi having been removed for therapeutic purposes—from eleven patients having trachoma, chiefly of Types I, IIa and IIb of MacCallan's designations,[1] that is, types of the disease characterized mainly by follicular reaction. The tissue was cultivated following the mode of procedure originally devised by Noguchi.[2]

Bacterium granulosis was recovered from four of the eleven cases. The subconjunctival inoculation of cultures of the recovered microorganisms induced progressive granular conjunctivitis in four *Macacus sinicus* monkeys.[3] The general appearance of the experimental disease in these animals was identical with that observed by Noguchi, ourselves and others in monkeys inoculated with *Bacterium granulosis*[2,4] isolated from cases of trachoma occurring in the United States. On our return to New York we inoculated similarly five *Macacus rhesus* monkeys with the four pooled Cairo cultures. From six to eighteen days after the injection, four of the animals showed the characteristic granular conjunctivitis.

The Cairo strains agree in morphological, cultural and serological properties and in effects on animals with those obtained from patients suffering from trachoma and residing in other parts of the world.[5]

No evidence was obtained implicating as the incitant of the disease in Egypt any other microbic or ultramicroscopic agents. We failed to find in the cells of the trachomatous lesions inclusion bodies of the kind characteristic of many ultramicroscopic viruses. On the other hand, the Prowazek-Halberstaedter bodies, which appear to be composed of bacterial elements,[6] were observed in seventeen of forty-eight cases of trachoma studied in Egypt. In all instances in which these structures were detected the material examined had been derived from patients suffering from secondary bacterial infections, usually with Koch-Weeks' bacilli, superimposed on the trachomatous lesions.[7]

In view of our failure to detect in Egypt any other causal agent of trachoma and from the positive findings regarding *Bacterium granulosis,* the conclusions of Noguchi on the causal relation of the organism to the human disease have received additional support.[8]

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BOOKS RECEIVED

MOORE, RAYMOND C. *Historical Geology.* Pp. xiii + 673. 413 figures. McGraw-Hill. $4.00.

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[1] A. F. MacCallan, "Trachoma and Its Complications in Egypt," pp. 1–74. London, Cambridge University Press, 1913.

[2] H. Noguchi, *Jour. Exp. Med.,* 48: Suppl. 2, pp. 1–53, 1928.

[3] All inoculations were made in ether-anesthetized animals.

[4] P. K. Olitsky, R. E. Knutti and J. R. Tyler, *Jour. Exp. Med.,* 54: 31, 1931; W. C. Finnoff and P. Thygeson, *Arch. Ophth.* (Chicago), 5: 527, 1931; C. Weiss, *Proc. Soc. Exp. Biol. and Med.,* 30: 908, 1933.

[5] F. Tallo, *Boll. Istit. Sieroterap. Milanese,* 11: 225, 1932; C. Weiss, *Arch. Institut Pasteur,* Tunis, 19: 433, 1930.

[6] See also A. W. Williams, *Jour. Inf. Dis.,* 14: 261, 1914; and I. A. Bengtson, *Am. Jour. Ophth.,* 12: 637, 1929.

[7] *Cf.* F. H. Stewart, Sixth. Ann. Rep. Giza Memorial Ophthalmic Laboratory, p. 107, Cairo, 1931.

[8] A full report of the investigations will be published in a forthcoming number of the *Archives of Ophthalmology.*